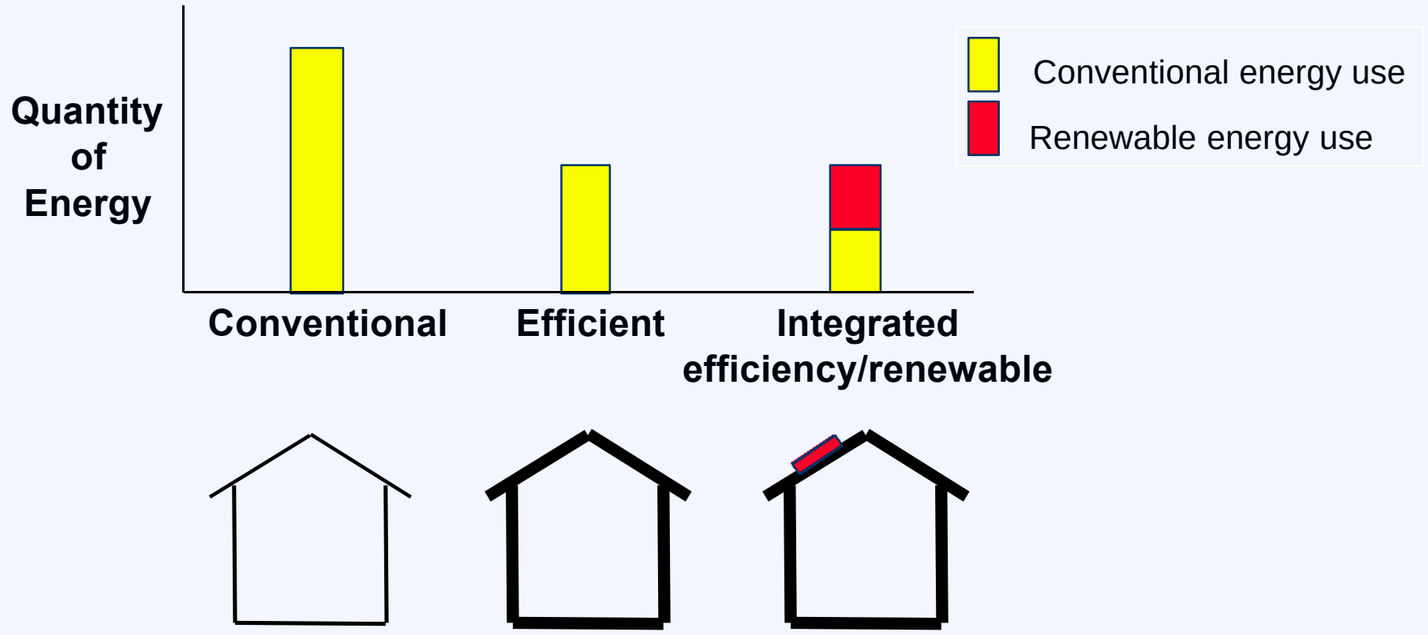
Sustainable Low Energy Design and Renewable Energy Opportunities

Otto Van Geet, PE

NREL

FEMP

Relationship between Efficiency/Renewables



FEMP

Why Efficiency and Renewables?

Electricity generation is the leading contributor to U.S. air pollution

66% of Sulfur Dioxide	*(acid rain)*
29% of Nitrogen Oxide	*(smog)*
36% of Carbon Dioxide	*(climate change)*
21% of Mercury	*(toxic chemical)*

FEMP

Low Energy Design and Renewable Energy Options

Low energy design for new buildings

On-site energy generation

R.E. Electricity Purchases

FEMP

Low Energy Design

NIH Louis Stokes Laboratory

Building 50

The optimization of orientation, building form, window location and size, and materials selection, coupled with efficient heating, cooling, and ventilating, to minimize the use of nonrenewable energy.

Typical savings can be 40-70% of the energy use over conventional base case

FEMP

Nine-Step Design Process

Pre-Design

1. Simulate a base case building model and establish goals (% energy reduction, LEED rating, etc.)

2. Complete parametric analysis

3. Design team brainstorms solutions

4. Perform simulations on base case variants

Design

5. Architectural team prepares preliminary drawings

6. Design the HVAC system

7. Finalize plans and specifications

Construction & Occupation

8. Rerun simulations before construction design changes

9. Commission all equipment and controls. Education building operator

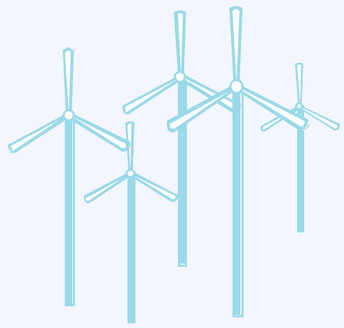
FEMP

Renewable Energy

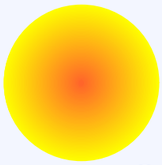
- A clean, secure, stable, sustainable source of thermal and electrical energy and liquid fuel

Sustainable Building Design

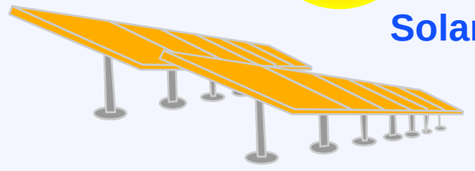
Alternative Fuels



Wind



Solar/PV



FEMP

Solar Water Heating :Indicators of Potentially Cost-Effective Applications

- Large water heating loads.
- High cost of backup energy (electricity, propane, etc.).
- Heating load constant throughout week and year (or more in the summer).
- Sufficient area to site collectors (1 ft^2/gal/d).
- Facility “Champion” to do project.

FEMP

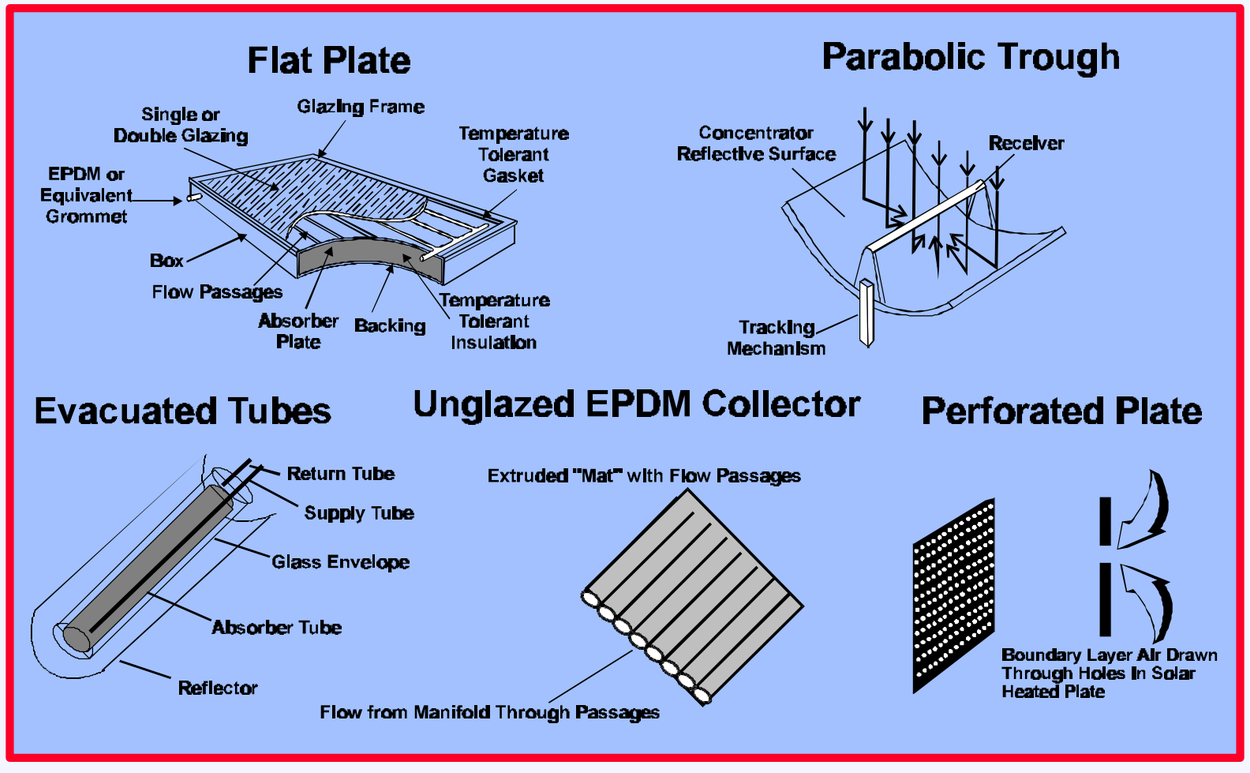
Technology Overview

Solar thermal collectors can be categorized by the temperature at which they efficiently deliver heat.

- Low-temperature collectors:
  - Unglazed mats for water heating.
  - Perforated plates for air preheating.
- Mid-temperature collectors:
  - Glazed and insulated collectors.
- High-temperature collectors:
  - Evacuated tubes.
  - Focusing collectors.

FEMP

Collector Types



Solar Water Heating

Phoenix Federal Correctional Institution

Financed, Installed (1998)
and Operated under
Energy Savings
Performance Contract with
Industrial Solar Technology, Inc

Environmental Protection Agency

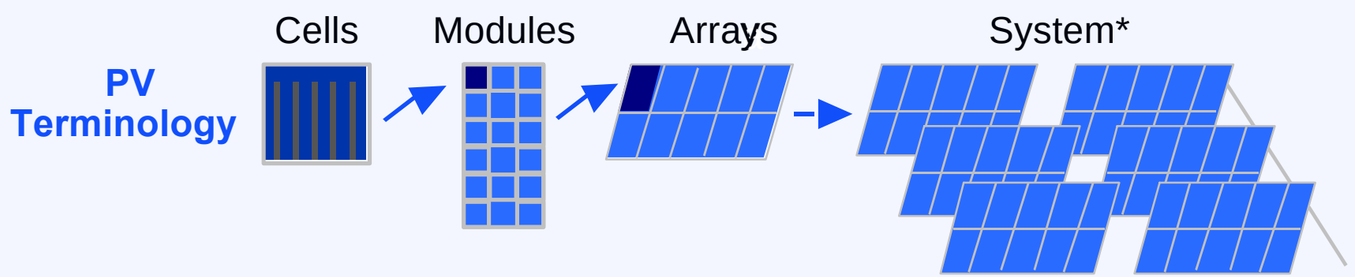
FEMP

What is Photovoltaics?

- **Photovoltaics** is a solid-state technology that converts solar radiation directly into electricity, with no moving parts; requiring no fuel, and creating virtually no pollutants over its life cycle.
- **Building-Integrated Photovoltaics (BIPV)** are systems where the PV elements become an integral part of the building, often serving as the exterior weathering skin.

FEMP

PV Terminology



*Includes storage, charge controls inverters, etc.

FEMP

Photovoltaics

GSA Williams Bldg,
Boston, MA

- **Most Cost Effective:**
  - ***Small Loads***
    - » ***Emergency Call Boxes***
    - » ***Irrigation Controls***
    - » ***Sign lighting / parking lot lights***
  - ***Avoided Line Extensions ($20k to $100k/mile)***
    - » ***Water Pumping***
    - » ***Residential***
  - ***Remote Diesel Generators ($0.19 to $1.68/kWh)***
  - ***Buildings integrated PV***
    - » ***Peak shaving and emergency power***

FEMP

Laboratory Projects Where PV Might be Cost-Effective

- Sites with very high electric utility rates (or very high demand charges);
- Locations remote from power lines;
- Applications where fail-safe redundancy is extremely important (UPS);
- Building integrated (such as south window shading)

FEMP

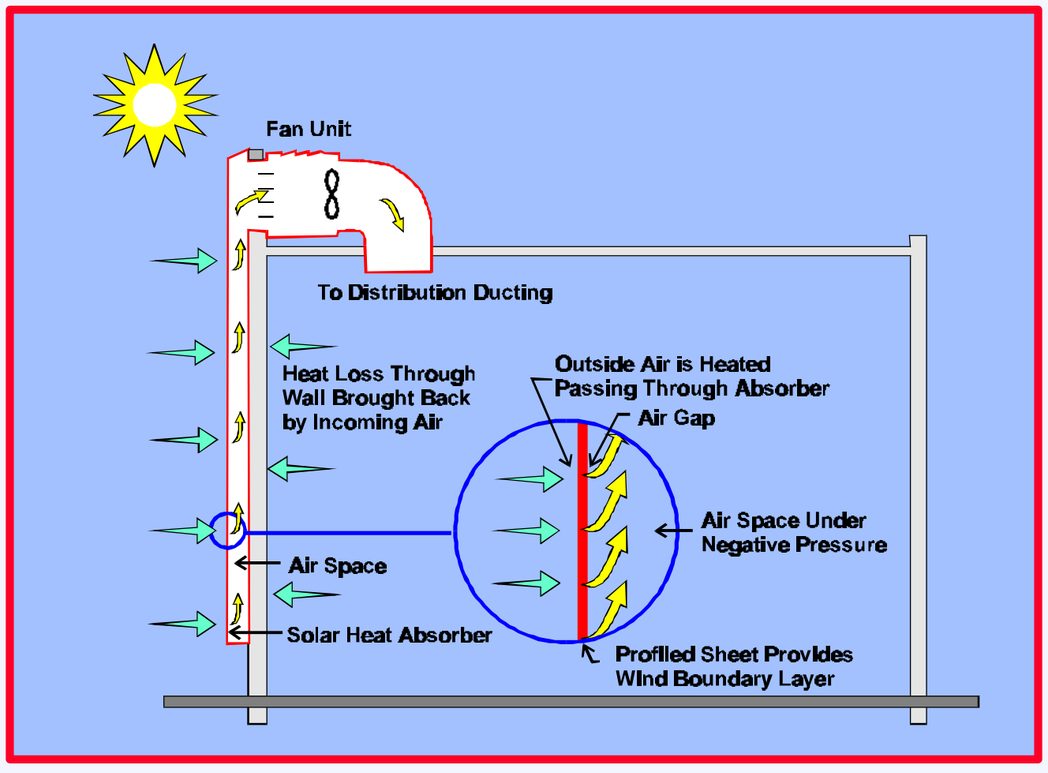
Building Integrated PV and Uninterruptible Power Supply (UPS)

EPA Facility & Utility	Demand Charge per kW	Energy Charge per kW	Bennefit Cost Ratio		Payback Period	
			Without UPS	With UPS	Without UPS	With UPS
Gulf Ecology Division Laboratory Gulf Power Company	$8.57	$0.0533	0.74	1.21	13	4
Robert S. Kerr Laboratory Oklahoma Gas & Electric	$5.94 peak $12.56	$0.0264	0.70	1.17	15	4
Emission Certification Laboratory Detroit Edison	$12.58	$0.0638	0.84	1.33	10	3
Great Lakes Research Laboratory Minnesota Power	$7.25	$0.0308	0.68	1.15	16	4

Assumes $8-9 per peak watt installed PV system and the need for UPS

FEMP

Solar Air Heater



FEMP

Example:
Solar Wall - NREL Chemical Storage Building

FEMP

When to Consider

- Cold climates
- New construction.
- Requirements for outside air and fan intake near south wall (includes penthouse walls--retrofit and new) exist.
- For retrofit, south wall requires new cladding.
- Available south wall area.
- High ventilation requirements.

FEMP

Advantages of Transpired Collectors

- Very low cost.
- Extremely reliable.
- No maintenance.
- High Efficiency (up to 80%).
- Operates near ambient temperature.
- No problems with freezing or fluid leaks.
- No storage required.

FEMP

What is Renewable Power?

- *The Federal government defines renewable energy as energy produced by solar, wind, geothermal and biomass power.*
- *Some states also include low-head hydro, fuel cells using renewable fuels and ocean or tidal energy*
- *Many utilities offer a "green-e" certified product. To be green-e certified in California, a product must be 50% renewable -energy-based electricity and the non-renewable portion of the product must be no more polluting than the system power*

FEMP

Federal Agency Goals

- E.O. 13123 renewable energy goal = 2.5% of Federal electricity from renewables by 2005 (500 MW). This can be from renewable electricity purchases, on-site renewable use or the use of passive solar building design
- Other goals
  - » 5.0% of Federal electricity from wind power by 2010 (1000 MW)
  - » 3.0 % DOE electricity from renewables by 2005 (50 MW)

FEMP

Why consider renewable power purchasing (rather than on-site generation)?

- *No up-front capital costs - pay added “cents\kWh” over time*
- *Its relatively easy*
- *No systems to maintain*
- *If you have no on-site renewable resource*
- *It’s good for company image and morale building*
- *Poor renewable resources on site*

The greenest kWh is the one that is not used! Always look for energy efficiency opportunities first!!

FEMP

How do I purchase it?

- Regulated markets

  --Many utilities offer a green pricing program where a customer can support the development of renewable electric generation sources by paying extra cents\kWH

- Competitive markets

  --Customer may purchase green power from a choice of suppliers

FEMP

How do I pay for it?

- *Savings from energy efficiency*
- *Savings from choosing an alternative energy supplier*
- *Students at University of Colorado recently voted to increase student fees*

FEMP

Completed Renewable Power Purchases for Labs

- *Case I: EPA Lab - Richmond, California*
  - ***Procured 100% green-e certified, renewable power (land-fill gas/geothermal)***
  - ***Annual load = 1800 MWH***
  - ***SMUD is the power provider, with a three year contract beginning in July 1999***
  - ***Total annual cost of power =$154K***
  - ***Added premium for green is 10% (+15K)***
- *Case II: EPA Lab - Golden, Colorado*
  - ***Purchased Windsource through the PSCO program***
  - ***Purchases 320 blocks(100 kWh/month) @$2.50\block (384,000 kWh\yr for $800) ($0.025/kWh)***
  - ***Represents 15-20% of the facility load***
  - ***Windsource was purchased in a "revenue-neutral" fashion from savings from a renegotiated gas contract.***

FEMP

Resources for more information

- **FEMP Web Site -** www.eren.doe.gov/femp/
- **EO 13123 -** www.eren.doe.gov/femp/aboutfemp/exec13123.html
- **GSA Green Power -**www.gsa.gov/pbs/centers/energy/green.htm
- **Wind Powering America -** www.eren.doe.gov/windpoweringamerica/
- **GeoPowering the West -** www.eren.doe.gov/geopoweringthewest/
- **GSA Request for Proposals -** www.gsa.gov/pbs/xu/co1.htm
- **DOD Request for Proposals -** www.desc.dla.mil/main/a/electric/index.htm
- **Green Power Network -**www.eren.doe.gov/greenpower/home.shtml

  1) Green Pricing Programs - www.eren.doe.gov/greenpower/pricing.shtml

  2) Competitive Green Power Products
  www.eren.doe.gov/greenpower/marketing.shtml

FEMP

Renewable generated electricity - a clean form of power

Ponnequine Wind Farm supplies clean renewable power for Public Service of Colorado

FEMP

Where to go for help:

- www.nrel.gov/
- www.eren.doe.gov
- www.epa.gov/labs21century/

FEMP